10/613,057 GRBCP0304US

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Dated: 4/5/2006

Christine Arndt
Christine Arndt

Attorney Docket No. GRBCP0304US **PATENT**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:

Applicant:	Michael Lee ZIEROLF	Art Unit:	3683
Serial No.:	10/613,057	Examiner:	Christopher P. Schwartz
Filed:	July 2, 2003		
Title:	BRAKE GAIN-BASED TORQUE CONTROLLER		

TRANSMITTAL OF APPEAL BRIEF

Mail Stop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Enclosed herewith is an Appeal Brief submitted with regard to the previously-filed appeal for the above application. A check for **$500.00** is enclosed for payment of the fee for submission of the Appeal Brief.

Authorization is given to charge any additional fees required in connection with any of these papers to our Deposit Account 18-0988.

Respectfully submitted,

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Michael Lee Zierolf

Serial No.: 10/613,057

Filing Date: July 2, 2003

For: BRAKE GAIN-BASED TORQUE CONTROLLER

Examiner: Christopher P. Schwartz

Art Unit: 3683

APPEAL BRIEF

Mailstop Appeal Brief-Patents
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This brief is being submitted in connection with the appeal of the above-identified application.

I. Real Party in Interest

The real party in interest in the present appeal is the Goodrich Corporation, the assignee of the present application.

II. Related Appeals and Interferences

Appellant, appellant's legal representatives, and/or the assignee of the present patent application are unaware of any appeals or interferences which will directly affect, or be directly affected by or have a bearing on the Board's decision in the pending appeal.

III. Status of Claims

Claims 1-3, 5-8 and 10-18 are pending in the application. Claims 1-3, 5-8 and 10-18 stand finally rejected and are the subject of this appeal.

IV. Status of Amendments

No claim amendments have been made subsequent to the final rejection.

V. Summary of Claimed Subject Matter

With reference to Fig. 1 (reproduced below), a brake system 10 includes a pilot brake device 12 (e.g., a brake pedal) for providing operator or pilot commanded brake control. The depression of the pedal is converted to an electrical signal (command torque signal T_c) that is provided to the brake gain-based torque controller 14. The value of the command torque signal T_c is indicative of the degree of depression of the pedal, and is related to the amount of braking torque commanded by the pilot.

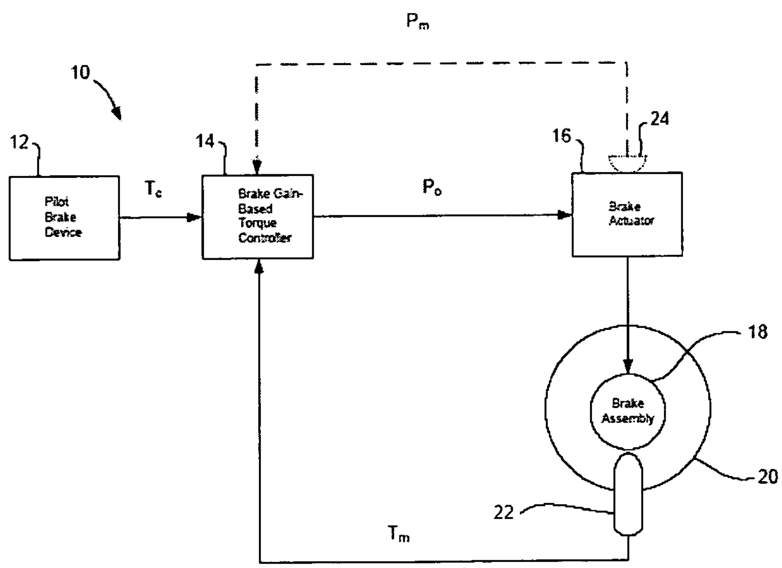

FIG. 1

In addition, the system 10 includes a brake gain-based torque controller 14. The brake gain-based torque controller 14 controls the amount of torque applied by the braking system. Specifically, the brake gain-based torque controller 14 is designed to provide a brake pressure output command signal P_o to a brake actuator 16 coupled to a brake assembly 18. The brake assembly 18 in turn provides braking action to a wheel

20 by exerting a braking torque or force on the wheel 20 as is conventional. The wheel 20 is coupled to the aircraft (or other vehicle) via a conventional structure (not shown).

The system 10 further includes a brake torque sensor 22 that measures the amount of torque exerted by the brake actuator 16 and brake assembly 18 on the wheel 20. The measured torque signal T_m is input to the brake gain-based torque controller 14.

The system 10 also includes a pressure sensor 24 (shown as a dashed line in FIG. 1), which measures the pressure created by the brake actuator 16. The output (shown as a dashed line in FIG. 1) of the pressure sensor 24, a measured pressure signal P_m, represents the pressure provided to the brake assembly 18, and is fed back to the brake gain-based torque controller 14. Thus, the measured pressure signal P_m is utilized as an input to the brake gain-based torque controller 14 representative of the applied pressure.

As will be described more fully below in relation to FIG. 2, the brake gain-based torque controller 14 utilizes a computed inverse brake gain in order to provide brake control for a vehicle, such as an aircraft. The computed inverse brake gain I_k is calculated using the measured torque signal T_m provided from the torque sensor 22, and the measured pressure signal P_m provided from the pressure sensor 24. The brake gain-based torque controller 14 then multiplies the desired torque, i.e., the command torque signal T_c, by the computed inverse brake gain I_k (i.e., the ratio of pressure to torque) to determine the amount of pressure to apply to the wheel 20 in order to achieve the desired torque, i.e., the brake pressure output command signal P_o.

The brake gain-based torque controller 14 effectively controls the pilot command torque signal T_c applied to the brake assembly 18. For example, if the wheel 20 has a measured torque signal T_m greater than the aforementioned desired command torque signal T_c, the brake gain-based torque controller 14 reduces the value of the brake

pressure output command signal P_o. In the event the wheel 20 has a measured torque signal T_m less than the desired command torque signal T_c, the brake gain-based torque controller 14 will increase the value of the brake pressure output command signal P_o until full pilot command torque signal T_c is applied to the brake assembly 18.

Referring now to FIG. 2 (reproduced below), a detailed block diagram of the brake gain-based torque controller 14 is shown. As represented in FIG. 2, the command torque signal T_c representing the desired amount of brake torque is provided to one input of a multiplier 26. The multiplier 26 multiplies the command torque signal T_c by a limited computed inverse brake gain I'_k (discussed in more detail below), which is provided to the other input of the multiplier 26. The output of the multiplier 26 represents a brake pressure output command signal P'_o, which, based on certain selection criteria, may be provided as output P_o of the controller 14.

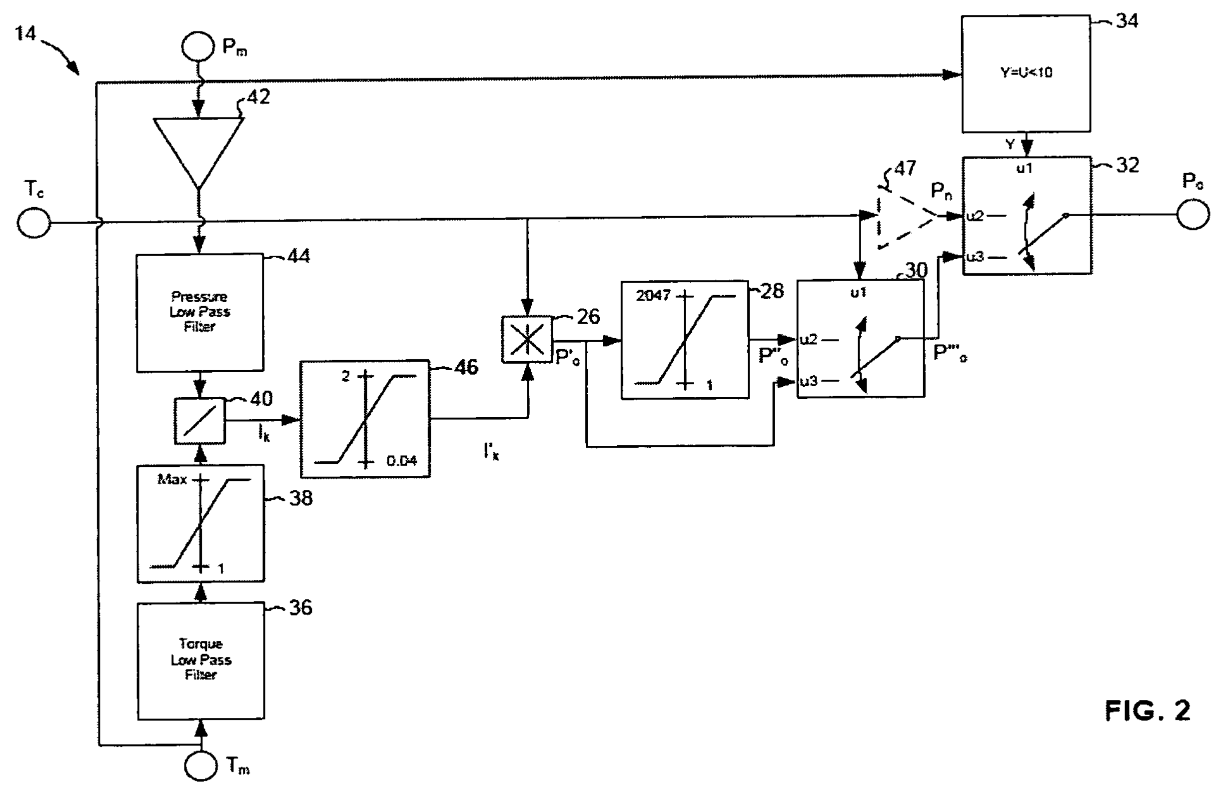

FIG. 2

Blocks 36-46 relate to the generation of the inverse brake gain signal. In the exemplary embodiment of FIG. 2, the measured torque signal T_m is filtered using a first order, low-pass filter 36, and then input to a positive limiter 38. The limiter 38 limits the measured torque signal T_m to a predefined positive range (e.g., 1 to max, e.g., 10,000 (not shown in Fig. 2)), and the limited signal is input to a denominator input of a divider 40. The positive limiter 38 limits a minimum value of the filtered measured torque signal to 1 in order to prevent divide by zero errors in the divider 40.

The measured pressure signal P_m is input to a gain amplifier 42 having a nominal gain in order to scale the measured pressure signal P_m. The output of the gain amplifier 42 is provided to a first order, low-pass filter 44 and, after filtering, the signal is input to a numerator input of the divider 40. The output of the divider 40 is the computed inverse gain I_k (i.e., P_m/T_m).

The computed inverse brake gain I_k is input to a limiter 46 having a lower limit of 0.04, for example, and an upper limit of 2, for example. The output of the limiter 46 is the limited computed inverse brake gain I'_k, which is input to the second input of the multiplier 26 as described above.

As the value of the limited computed inverse brake gain I'_k varies, the maximum brake pressure output command signal P_o that is passed on to the brake actuator 16 is controlled.

VI. Grounds of Rejection to be Reviewed on Appeal

A. Whether claims 1-3, 5-8 and 10-18 are patentable under 35 U.S.C. §103(a) over U.S. Patent No. 6,220,676 to *Rudd* in view of U.S. Patent No. 6,036,285 to *Murphy*.

VII. Argument

A. Claims 1-3, 5-8 and 10-18

Claims 1-3, 5-8 and 10-18 stand finally rejected as being unpatentable over the applied art. For the following reasons, it is respectfully submitted that the claims are patentable over the applied art and the final rejection should be withdrawn.

Claims 1-3, 5-18 and 10-18 have been rejected under 35 U.S.C §103(a) as being unpatentable over *Rudd* in view of *Murphy*. In rejecting the claims, the Examiner contends that *Rudd* discloses use of the inverse of torque to pressure (i.e., inverse brake gain).[1] Applicant respectfully requests reversal of the rejection for at least the following reasons.

1. Claims 1 and 17 - *Rudd* in View of *Murphy* Do Not Teach or Suggest Using a Computed Inverse Brake Gain Based on the Signal Indicative of a Measured Amount of Brake Torque Applied to the Wheel and a Measured Pressure Signal Indicative of an Amount of the Brake Pressure Applied by the Brake Assembly

Independent claim 1 recites a brake gain-based torque controller that adjusts a brake pressure output command provided to a brake actuator and a brake assembly **using a <u>computed inverse brake gain based on a signal indicative of a measured amount of brake torque</u> applied to the wheel and <u>a measured pressure signal</u> indicative of an amount of the brake pressure applied by the brake assembly**. Independent claim 17 recites a brake control system that includes a brake gain-based torque controller, wherein during normal braking a <u>torque signal and a measured pressure signal are fed into the brake gain-based torque controller to determine a computed inverse brake gain</u> to calculate the brake pressure output command of the brake gain-based torque controller in order to control the pressure to the wheel to achieve the command torque output.

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1. Page 3, first paragraph of the Office Action dated October 18, 2005.

As discussed above, the torque command signal is multiplied by an inverse brake gain I'_k (i.e., measured pressure / measured torque). As the value of the limited computed inverse brake gain I'_k varies, e.g., from "0" to "1", the maximum brake pressure output command signal P_o that is passed on to the brake actuator 16 is controlled.

Rudd describes an anti-skid brake system that utilizes torque feedback, wherein a torque sensor provides a brake torque feedback signal to a Kalman filter based controller.[2] *Rudd* relies on the Kalman filter to estimate brake gain based on the measured torque. *Rudd*, however, has not been found to teach or suggest a controller that evaluates inverse brake gain utilizing **measured brake torque** *and* **measured brake pressure**, as recited in claims 1 and 17.

The Examiner contends that *Rudd* discloses a system that utilizes inverse brake gain as recited in claims 1 and 17, and points to equation 13 of *Rudd* as evidence of such teaching.[3] Referring to the cited portion of *Rudd*, there is disclosed equation 13, which is shown below.

$$P_p=(\mu_p/k)[W_t r+g(1-r_p)/r] \qquad \text{Equation 13}^4$$

Equation 13 is related to determining the peak pressure that can be applied to the brakes (P_p).[5] As can be seen, the equation includes the term μ_p/k, wherein μ_p represents the peak coefficient of friction and k is defined by equation 6, which also is shown below.

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2. See, e.g., Fig. 1 of *Rudd*.

3. Page 3, first paragraph of the Office Action dated October 18, 2005.

4. Column 8, line 27 of *Rudd*.

5. Column 8, lines 10-11 of *Rudd*.

$k=n+n_f$ Equation 6[6]

In Equation 6, n represents the actual noise for the respective parameters and n_f represents the fictitious noise for the respective parameters.[7] *Rudd* refers to k as the torque to pressure ratio.

As best understood, the Examiner's argument is that since *k* is referred to as the "torque to pressure ratio" (e.g. Torque/Pressure or T/P), and since *k* is in the denominator of equation 13, equation 13 effectively can be written as μ_p *P/T and, according to the Examiner, this teaches the inverse brake gain of claims 1 and 17. Applicant respectfully disagrees.

As noted above, claims 1 and 17 recite using signals indicative of a measured torque (T_m) and measured pressure (P_m) to compute the inverse brake gain. Equation 13 (which uses the parameter *k* that allegedly teaches the inverse brake gain) calculates a peak pressure that ***may*** be applied to the brakes while remaining at the top of the mu-slip curve.[8] Thus, the peak pressure (P_p) as defined by equation 13 is a calculated value that dictates a maximum desired pressure applied by the brake. Peak pressure (P_p), however, is not a measured pressure, as recited in claims 1 and 17. Moreover, *Rudd* expressly states that *k* represents an "estimated torque/pressure ratio".[9] This is because while torque is measured, brake pressure is not measured and, hence, the torque/pressure ratio can only be estimated.

Further, while *Rudd* does refer to the parameter *k* as the "torque to pressure ratio" and, in particular an estimated torque to pressure ratio, throughout *Rudd k* is

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6. Column 7, line 29 of *Rudd*.

7. Column 7, lines 51-54 of *Rudd*.

8. Column 7, line 67-column 8, line 3, and column 8, lines 10-11 pf *Rudd*.

9. Column 16, lines 64-65 of *Rudd*.

defined in terms of noise (i.e., the actual noise *n* and fictitious noise n_f as shown in equation 6) and not torque or pressure.[10] Clearly, this estimated parameter is not obtained from actual measurements of torque and pressure.

Accordingly, *Rudd* has not been found to teach or suggest measuring the brake pressure for purposes of calculating the inverse brake gain as recited in claims 1 and 17.

Murphy describes a brake controller that utilizes both measured brake torque and measured brake pressure. However, *Murphy* teaches using the measured brake torque and measured brake pressure to transition between open loop torque control and closed loop pressure control.[11] *Murphy* has not been found to make up for the deficiencies of *Rudd*. More specifically, *Murphy* has not been found to teach or suggest measuring the brake pressure for purposes of calculating the inverse brake gain, as recited in claims 1 and 17.

Further, and assuming *Rudd* and *Murphy* are combinable, it is respectfully submitted that such combination would not yield the invention of claims 1 and 17, as discussed below.

Rudd describes a brake control system that provides torque feedback to a Kalman filter to estimate brake gain, while *Murphy* measures both pressure and torque to transition between open loop torque control and closed loop pressure control. Assuming *Rudd* and *Murphy* are combinable, such combination would result in a Kalman based controller that transitions between torque control and pressure control. Missing from this combination, however, is a brake controller that implements inverse brake gain based on measured pressure and measured torque, as recited in claims 1

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10. See, e.g., column 7, lines 29 and 51-54 and column 29, line 15 of *Rudd*.

11. See column 8, lines 35-49 of *Murphy*.

and 17. Recall that *Rudd* defines the "torque to pressure ratio" *k* based on noise parameters, without any teaching or suggestion that this parameter may be defined using measured pressure. Thus, simply by including the measured pressure of *Murphy* (which is used for transitioning between open loop torque control and closed loop pressure control) into the system of *Rudd*, one would not be motivated to redefine the "torque to pressure ratio" *k* of Rudd (i.e. $k=n+n_f$). The Kalman based controller as disclosed in *Rudd* still would use the parameter k defined in terms of noise, and not measured pressure.

Further, the Examiner's motivation to combine the references is to offer "smoother brake control".[12] Such "smoother brake control" is due to transitioning between control schemes (i.e., open loop torque control to closed loop pressure control). Assuming that one skilled in the art would combine *Rudd* and *Murphy* to achieve smoother brake control, the desire for smoother brake control would not motivate one to redefine the parameter *k*, as presumably the desired result (i.e., smoother or "less grabby" brakes) is achieved by using two different control schemes as taught by *Murphy*. Accordingly, the Examiner has not set forth a *prima facie* basis for the rejection of claims 1 and 17.

Accordingly, *Rudd* in view of *Murphy* has not been found to teach or suggest all the features of claims 1 and 17 and, therefore, reversal of the rejection of claims 1 and 17 is respectfully requested.

2. Claim 13 - *Rudd* in view of *Murphy* Do Not Teach or Suggest a Torque Controller that Includes a Gain Block that Receives as an Input a Pressure Signal and Outputs a Signal that is Scaled to the Signal Indicative of the Amount of Brake Torque Applied to the Wheel

Claim 13 recites that the torque controller includes a gain block which receives as an input the pressure signal and outputs a signal that is scaled to the signal

12. Page 3, fifth paragraph of the Office Action dated October 18, 2005.

indicative of the amount of brake torque applied to the wheel. As discussed above, *Rudd* clearly does not teach or suggest use of a measured pressure signal and, thus, cannot teach this feature. Further, while *Murphy* does teach the used of a measured pressure signal, *Murphy* simply has not been found to disclose that such signal is scaled to a signal indicative of an amount of brake torque applied to the wheel, as recited in claim 13.

Accordingly, *Rudd* in view of *Murphy* has not been found to teach or suggest all the features of claim 13 and, therefore, reversal of the rejection of claim 13 is respectfully requested.

3. Claim 14 - *Rudd* in view of *Murphy* Do Not Teach or Suggest that a Measured Torque Signal is used as an Upper Limit of a Limiter of the Brake Gain-based Torque Controller in Order to Prevent Damage to a Tire

Claim 14 recites that the measured torque signal T_m is used as an upper limit of a limiter of the brake gain-based torque controller in order to prevent damage to a tire. *Murphy* discloses several limiters[13], but none of these limiters have been found to teach or suggest the use of measured torque as an upper limit of a limiter of the brake gain-based controller. Further, *Rudd* briefly discusses rate limiters[14], but like *Murphy*, none of these rate limiters use of measured torque as an upper limit of a limiter of the brake gain-based controller, as recited in claim 14.

Accordingly, *Rudd* in view of *Murphy* has not been found to teach or suggest all the features of claim 14 and, therefore, reversal of the rejection of claim 14 is respectfully requested.

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13. See, e.g., Fig. 3, blocks 40 and 50 of *Murphy*.

14. See, e.g., column 5, lines 11-13 of *Rudd*.

4. Claim 15 - *Rudd* in view of *Murphy* Do Not Teach or Suggest a Brake Gain-based Torque Controller Limits the Brake Pressure Output Command Based on the Measured Torque as a Function of the Measured Torque

Claim 15 recites that the brake gain-based torque controller limits the brake pressure output command based on the measured torque as a function of the measured torque. As discussed above with respect to claim 14, neither *Rudd* nor *Murphy* have been found to teach or suggest using the measured torque as an upper limit of a limiter. Thus, *Rudd* and *Murphy* also cannot teach that the brake pressure output command is limited based on the measured torque as a function of the measured torque, as recited in claim 15.

Accordingly, *Rudd* in view of *Murphy* has not been found to teach or suggest all the features of claim 15 and, therefore, reversal of the rejection of claim 15 is respectfully requested.

5. Claim 16 - *Rudd* in view of *Murphy* Do Not Teach or Suggest a Brake Gain-based Torque Controller that Includes Circuitry that Limits the Brake Pressure Output Command Based on the Measured Torque as a Function of the Measured Torque

Claim 16 recites that the brake gain-based torque controller includes circuitry which limits the brake pressure output command based on the measured torque as a function of the measured torque. As discussed above with respect to claim 14, neither *Rudd* nor *Murphy* have been found to teach or suggest using the measured torque as an upper limit of a limiter. Thus, *Rudd* and *Murphy* also cannot teach that the brake gain-based torque controller includes circuitry which limits the brake pressure output command based on the measured torque as a function of the measured torque, as recited in claim 16.

Accordingly, *Rudd* in view of *Murphy* has not been found to teach or suggest all the features of claim 16 and, therefore, reversal of the rejection of claim 16 is respectfully requested.

VIII. Conclusion

In view of the foregoing, appellant respectfully submits that the claims are patentable over *Rudd* in view of *Murphy* and that the final rejection should be reversed.

Respectfully submitted,

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CERTIFICATE OF MAILING

I hereby certify that this paper (along with any paper or item referred to as being attached or enclosed) is being deposited with the United States Postal Service on the date shown below with sufficient postage as first-class mail in an envelope addressed to Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450

Date: 4/5/2006 Christine Arndt

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IX. Claims Appendix

1. A brake gain-based torque controller, comprising:

an input for receiving a command torque indicative of a desired amount of brake torque applied to a wheel of a vehicle;

an input for receiving a signal indicative of a measured amount of brake torque applied to the wheel ,

an output for providing a brake pressure output command to a brake actuator and a brake assembly which applies a brake pressure to the wheel based on the brake pressure output command, and

an input for receiving a pressure signal which is indicative of an amount of pressure applied to the wheel by the brake assembly from a pressure sensor operatively coupled to the brake actuator and the brake assembly for measuring the amount of pressure applied to the wheel,

wherein during normal braking the brake gain-based torque controller adjusts the brake pressure output command provided to the brake actuator and the brake assembly using a computed inverse brake gain based on the signal indicative of a measured amount of brake torque applied to the wheel and a measured pressure signal indicative of an amount of the brake pressure applied by the brake assembly to provide improved brake response during normal braking.

2. The brake gain-based torque controller of claim 1, wherein the brake gain-based torque controller is configured to limit the brake pressure output command based on the measured amount of brake torque applied to the wheel.

3. The brake gain-based torque controller of claim 1, further including:

an output for providing the computed inverse brake gain to scale the brake pressure output command, wherein the computed inverse brake gain is a function of the brake torque applied to the wheel resulting from

an amount of pressure applied to the wheel by the brake actuator via the brake assembly.

5. The brake gain-based torque controller of claim 1, wherein the brake pressure output command is operative to control a pressure valve included in the brake actuator and the brake assembly.

6. The brake gain-based torque controller of claim 1, wherein the brake pressure output command is operative to control a flow valve included in the brake actuator and the brake assembly.

7. The system of claim 1, wherein the vehicle is an aircraft.

8. The system of claim 1, wherein the vehicle is an automobile.

10. The brake gain-based torque controller of claim 1, wherein the pressure sensor is configured for measuring an amount of pressure of a fluid controlled by a flow valve, the amount of pressure being indicative of an amount of brake force applied to the wheel.

11. The brake gain-based torque controller of claim 1, wherein the signal indicative of the amount of brake torque applied to the wheel is a measured torque signal Tm.

12. The brake gain-based torque controller of claim 11, wherein the measured torque signal T_m is fed into the brake gain-based torque controller to determined the computed inverse brake gain based on the desired response characteristics of the brake gain-based torque controller.

13. The brake gain-based torque controller of claim 1, further including:

a gain block which receives as an input the pressure signal and outputs a signal that is scaled to the signal indicative of the amount of brake torque applied to the wheel.

14. The brake gain-based torque controller of claim 13, wherein the measured torque signal T_m is used as an upper limit of a limiter of the brake gain-based torque controller in order to prevent damage to a tire.

15. The brake gain-based torque controller of claim 1, wherein the brake gain-based torque controller limits the brake pressure output command based on the measured torque as a function of the measured torque.

16. The brake gain-based torque controller of claim 15, further including:

circuitry which limits the brake pressure output command based on the measured torque as a function of the measured torque.

17. A brake control system, comprising:

an operator command device;

a brake gain-based torque controller coupled to receive as a first input, a command torque output of the operator command device;

a brake actuator coupled to receive a brake pressure output command from the brake gain-based torque controller;

a brake assembly coupled to a wheel to apply a pressure to the wheel based on an output of the brake actuator coupled thereto;

a torque sensor coupled to the wheel to provide a torque signal to the brake gain-based torque controller indicative of the torque applied by the wheel to a vehicle, to which the wheel is coupled; and

a pressure sensor operatively coupled to the brake actuator and the brake assembly for measuring the amount of pressure applied to the

wheel and for providing to the brake gain-based torque controller an input signal indicative of an amount of pressure applied to the wheel by the brake assembly,

wherein during normal braking the torque signal and pressure signal are fed into the brake gain-based torque controller to determine a computed inverse brake gain to calculate the brake pressure output command of the brake gain-based torque controller in order to control the pressure to the wheel to achieve the command torque output that improves brake response during normal braking.

18. The brake gain-based torque controller of claim 17, wherein the brake gain-based torque controller is configured to limit the brake pressure output command based on the measured amount of brake torque applied to the wheel.

X. Evidence Appendix

None

XI. Related Proceedings Appendix

None